CNTT-E-118

BASIC ELECTRICITY AND ELECTRONICS

STUDENT HANDOUT NO. 211

SUMMARIES PROGRESS CHECKS FOR MODULES

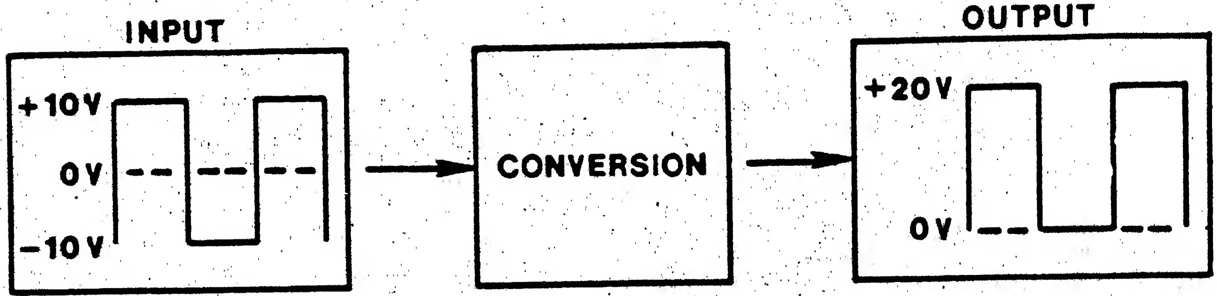
24 LESSONS 2&3

JUNE 1984

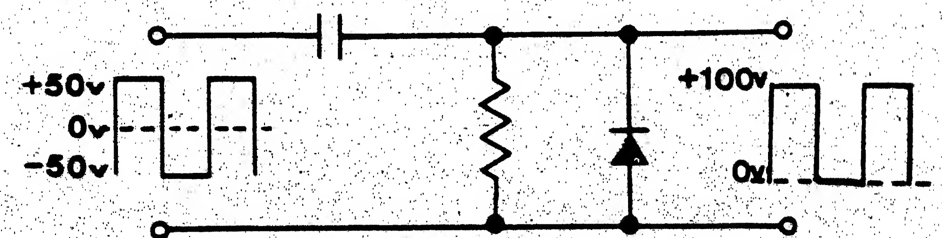
SUMMARY
LESSON II

Clampers

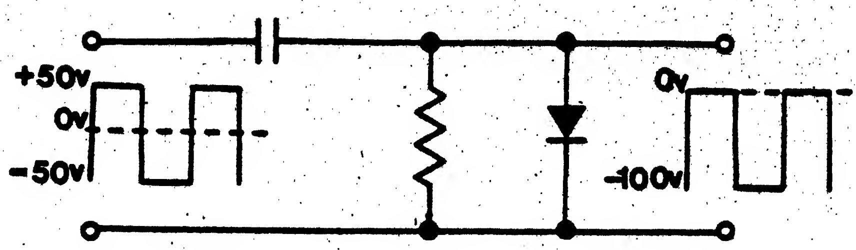
Clampers, sometimes called DC restorers, are used to raise or lower a reference voltage. They are used in test equipment, radar systems, electronic countermeasures systems, and sonar systems. Depending upon your equipment, you could find negative or positive clampers, with or without bias. In this lesson, you will learn the function of the different types, and the circuitry that constitutes each type. Let's look at an ICO diagram of a clamper.



Since you clipped a sine wave and made a square wave in the last lesson, let's use a square wave input. This waveform will vary its amplitude from +50V to -50V with its reference at zero volts. When you apply this input to a positive clamper, the output amplitude will now range from 0V to almost +100 volts. If you apply the same input to a negative clamper, the output amplitude will range from 0V to almost -100V. Let's look at the schematic diagram.

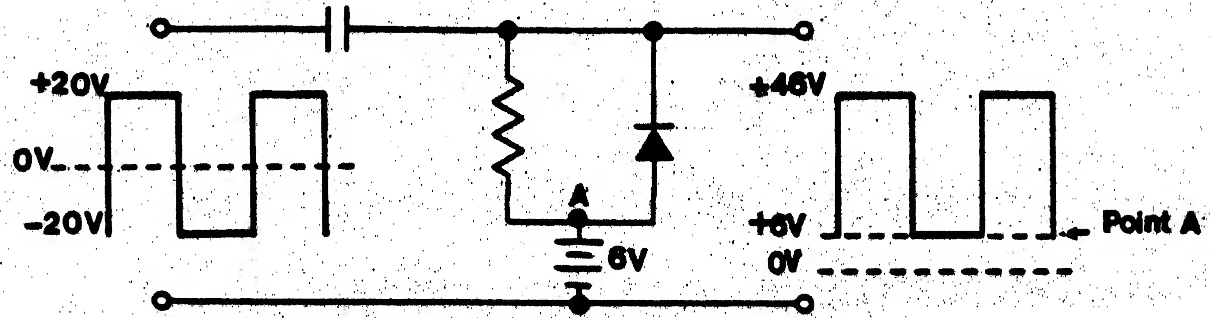


Positive Clamper

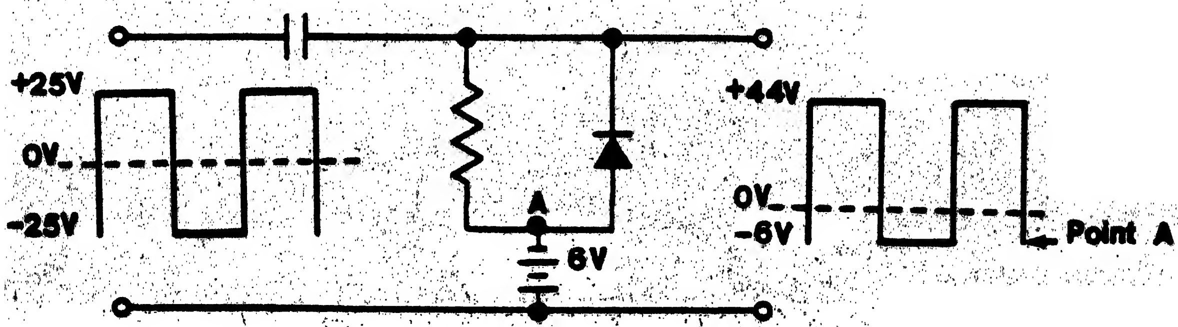


Negative Clamper

Remember when you inserted a DC potential into the clipper circuit? It established the output reference level for the circuit. Well, a DC potential does the same thing in a clamper circuit. Below are some examples of biased clampers.



Positive Clamper with Positive Bias



Positive Clamper with Negative Bias

At this time you may be asking yourself "How do these circuits work?" It's all in the time constants. The diode (forward biased) and capacitor produce a very short time constant. When the diode is reverse biased the resistor and capacitor produce a very long time constant. This action of short and long time constants keeps the voltage across the capacitor constant. Keeping the voltage level almost constant across the capacitor raises or lowers the output voltage reference level.

AT THIS POINT YOU SHOULD PROCEED TO THE JOB PROGRAM.

JOB PROGRAM
FOR
LESSON II

Clippers, Clampers

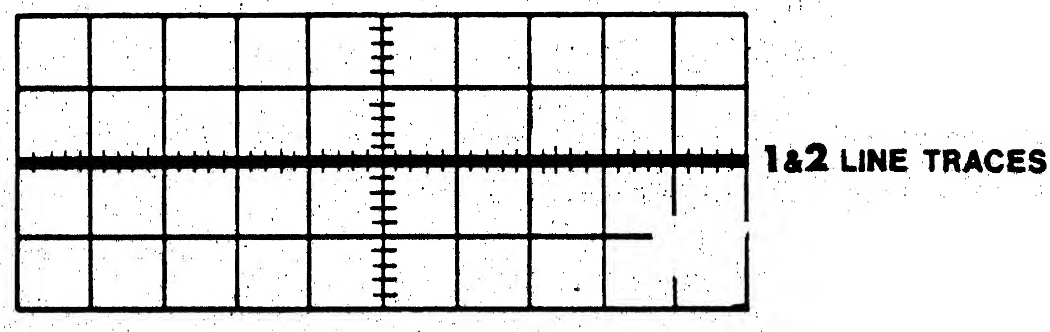
EQUIPMENT AND MATERIALS

1. Device 6F16 and TEMPLATE "F"
2. Oscilloscope
3. 1X Test Probe (2)
4. Patch Cords (2)

PROCEDURE

1. Energize oscilloscope, and set it up for dual trace operation.

    a. Obtain a line trace on both channels.
    b. Place the DISPLAY MODE Switch in the chop position.
    c. Re-adjust both channel line traces so that they are exactly on top of each other. (See illustration).



    d. Ensure that both VARIABLE VOLTS/DIV controls are "clicked" into their calibrated positions.

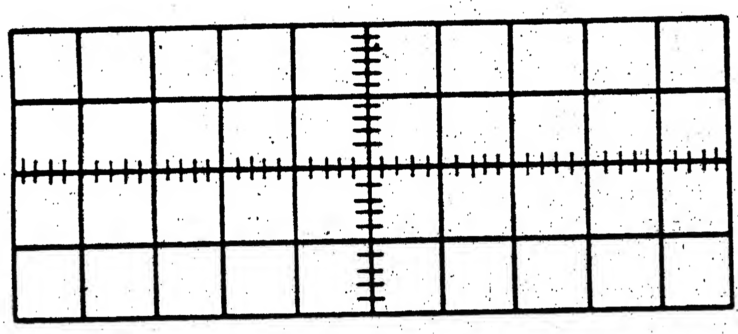
e. Place Channels 1 and 2 AC/DC switches to the "DC" position.
f. Set TIME/DIV to 5 msec/div.
g. Channel 1 and 2 VOLTS/DIV to 10 V/DIV.
h. Connect test probes to Channels 1 and 2 on oscilloscope.

2. a. Place Template F labeled "Introduction to Clampers" on the 6F16.
   b. Locate the components and place them in their proper positions.

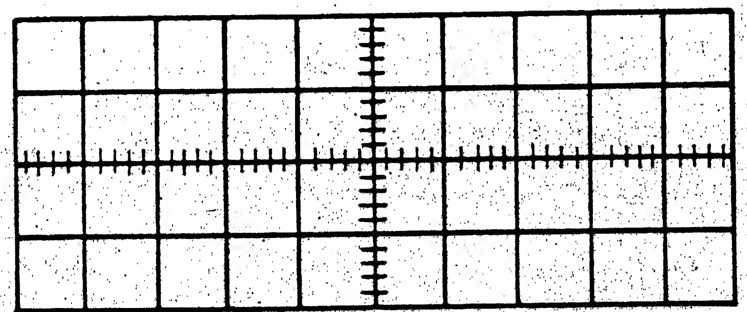
   NOTE: Make sure the (+) end of the capacitor is to the right.

   c. Energize the 6F16 device.

3. a. Connect channel 1 test probe to the input of the clamper circuit. Observe and draw the input waveform.



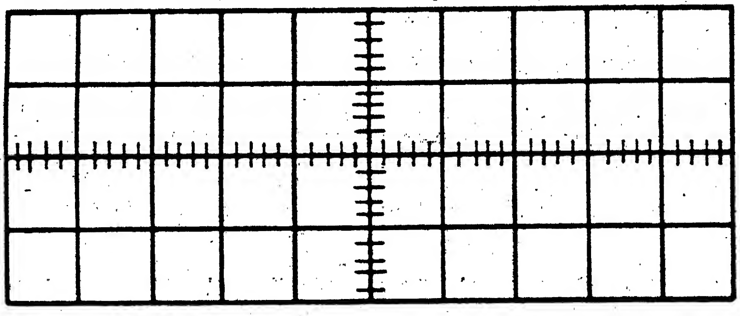
4. Place the channel 2 test probe on the output of the clamper circuit. (HINT: Either at the top of the diode or the top of the resistor; they're in parallel). Observe and draw the output.



Is this a positive or a negative clamper? ______________________

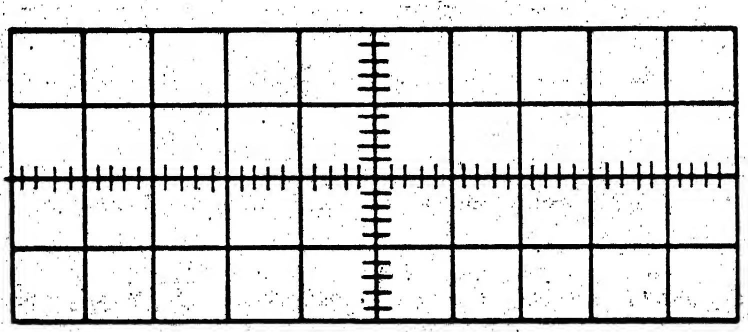
At what voltage level is the signal being clamped? ______________________

5. Now, secure the power and reverse D1 and C1, re-energise circuit and observe and draw the TWO waveforms.



What type of clamper is this? ________________________________

6. Secure the power and remove the bottom shorting strip (the lower one of the two that grounds the resistor and diode). Using one of the patch cords, jumper from the top hole where the shorting strip was to the negative side of the battery. Using the other patch cord jumper from the bottom hole to the positive side of the battery. Re-energize the circuit and draw the output waveform.

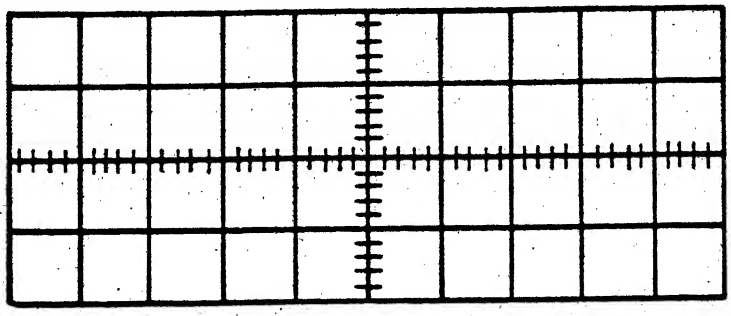


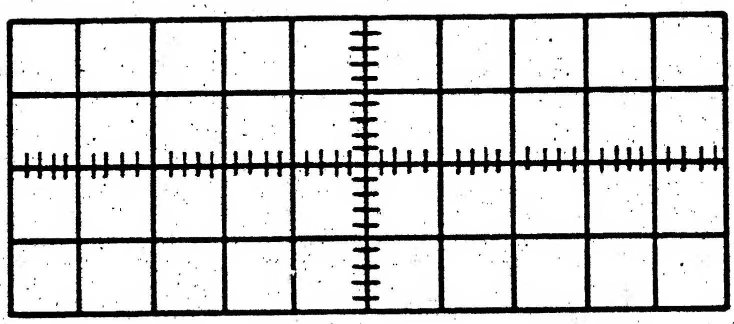
To what voltage level is the output waveform clamped? ________________

7. Now, reverse the patch cords so that the positive side of the battery is connected to the top hole, and the negative side of the battery is connected to the bottom hole. Is the output clamped the same amount in the other direction?

____

8. Secure the power, and reverse the diode and capacitor again. Observe and draw the waveforms using positive and negative bias. (Remember, to reverse the polarity of the bias simply reverse the patch cords).





You have just built and seen six different types of clampers in action.

9. Secure the power, and return all equipment to it's proper stowage.

CHECK YOUR RESPONSES TO THIS JOB PROGRAM WITH THE ANSWER SHEET. IF YOUR RESPONSES AGREE WITH THE ANSWER SHEET, YOU MAY TAKE THE LESSON PROGRESS CHECK. IF YOUR RESPONSES DO NOT AGREE OR IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST OF THIS JOB PROGRAM, REVIEW THE PROCEDURES OF THIS JOB PROGRAM, ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR UNTIL YOUR RESPONSES DO AGREE.

PROGRESS CHECK
LESSON 11

Clampers

1. The function of a clamper circuit is to

   a. amplify the input waveform.
   b. attenuate the input waveform.
   c. raise or lower the reference level of the input waveform.
   d. make the input waveform oscillatate.

2. A clamper is sometimes referred to as a ______________ ______________.

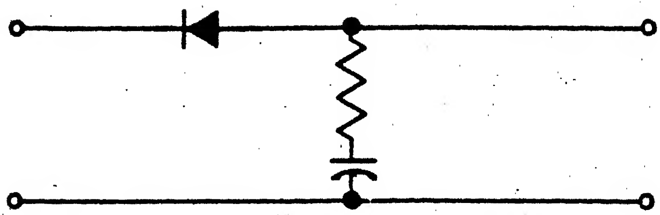
3. A positive clamper with no bias would clamp the input waveform (above/below) the original reference level.

4. The input waveform to a positive clamper could be a

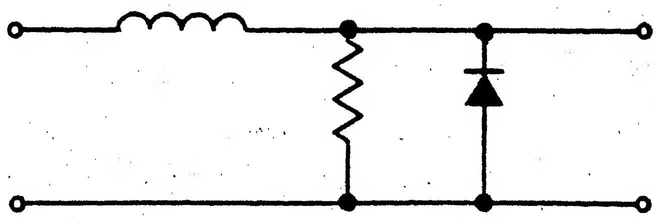
   a. square wave.
   b. sine wave.
   c. triangular wave.
   d. pulsed input.
   e. All of the above.

5. Which of the below illustrated circuits could be classified as a clamper circuit?

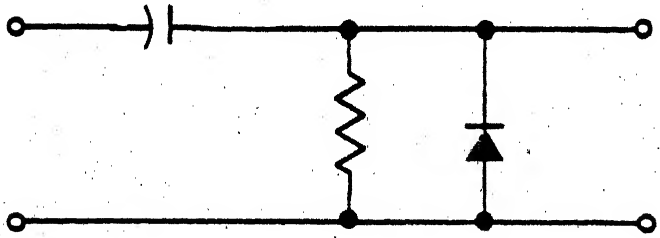
a.



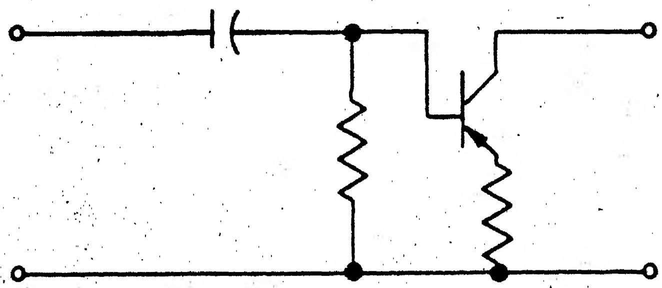
b.



c.



d.



6. In the RC network, the value of the _______ _______ is very important.

7. The only physical difference between a positive and negative clamper is

   a. the way the diode is placed in the circuit.
   b. the amount of amplification in the circuit.
   c. the time constant of the circuit.
   d. the size of the resistor in the circuit.
   e. the size of the capacitor in the circuit.

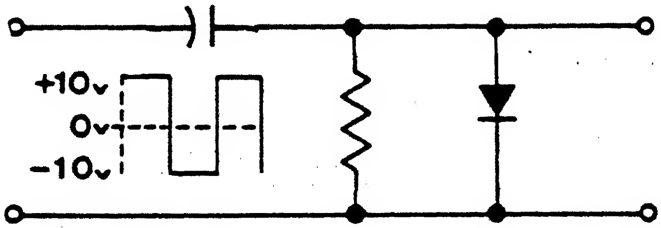
8. In a clamper circuit, the time constant should be (long/short) with respect to the input pulse.

9. In a biased clamper circuit the value of the _______ will be the output reference level.

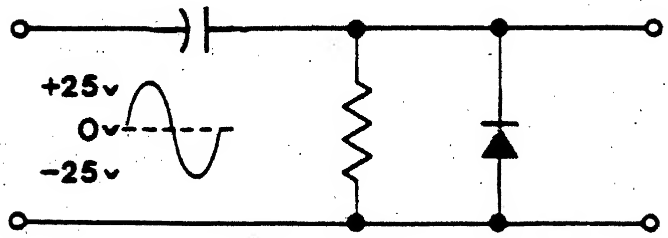
   a. time constant
   b. DC potential
   c. input reference level
   d. amplification factor of the diode

10. For the circuits below, draw the output waveform.

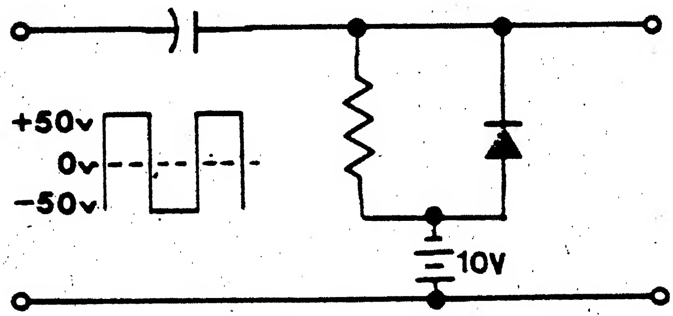
a.



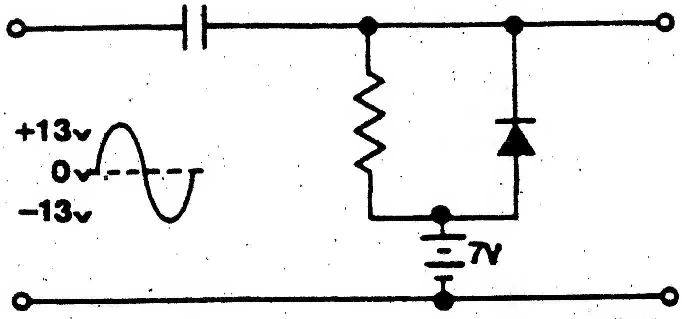
b.



c.



d.



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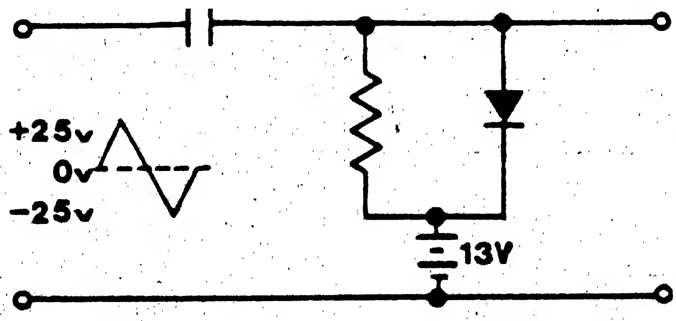
e.



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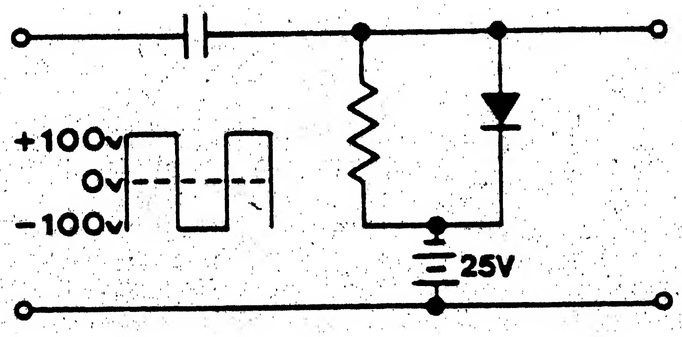
f.



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11. Using the circuits illistrated in the last question, identify each by its correct name.

Example: positive clamper with negative bias.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

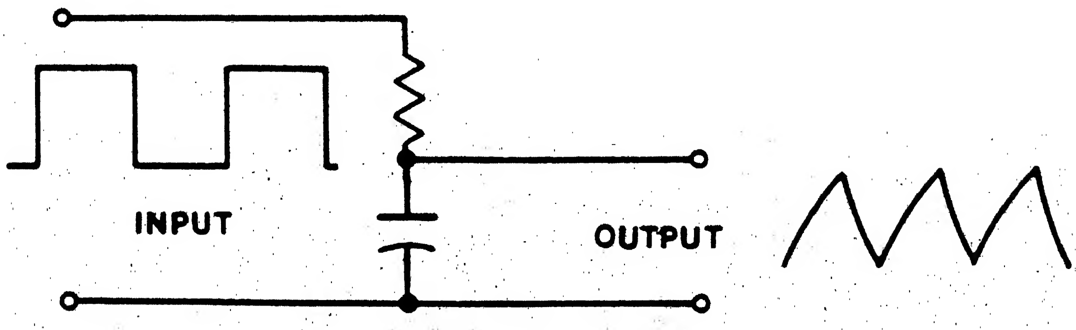
f. ______________________________

CHECK YOUR RESPONSES TO THIS PROGRESS CHECK WITH THE ANSWER SHEET. IF YOU ANSWER ALL SELF-TEST ITEMS CORRECTLY, CONSULT YOUR LEARNING CENTER INSTRUCTOR FOR ASSIGNMENT TO THE MODULE TEST PART ONE. IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST OF THE LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR UNTIL YOU CAN ANSWER ALL SELF-TEST ITEMS ON THE PROGRESS CHECK CORRECTLY.

SUMMARY
LESSON III

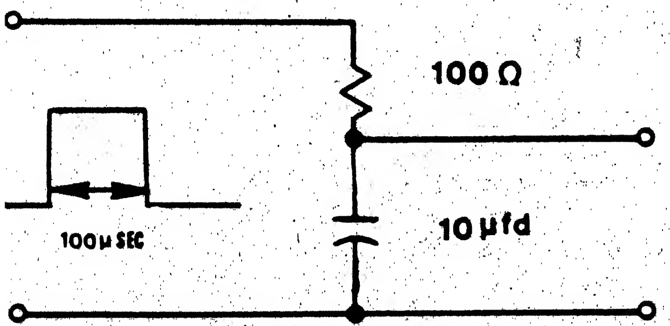
Integrators and Differentiators

In this lesson we will discuss integrators and differentiators. These circuits are used for waveshaping; both have square wave inputs. Integrators have triangular waveforms for outputs.



RC INTEGRATOR

The output is taken across the capacitor. The time constant of the RC network is long with respect to the time of the input pulse width. The time constant will usually be 10 times or more longer than the input pulse width.



RC Integrator

$T = RC$

$= 100 \times 10 \times 10^{-6}$

$= 1000$ µsec

$= 1$ msec

RC INTEGRATOR

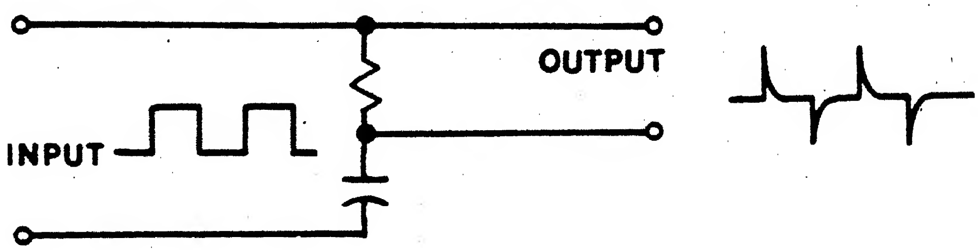
In short, RC integrators have the following characteristics:

1. Square wave input - triangular output.

2. The output is taken across the capacitor.

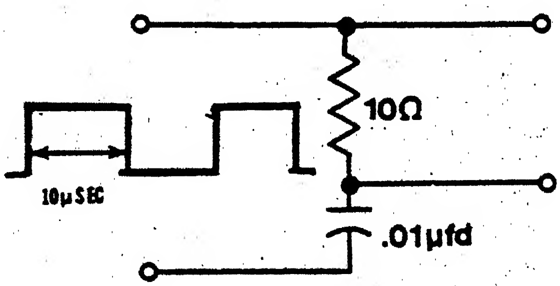
3. RC time constant is long with respect to the input width; usually 10 times or more longer.

This lesson also concerns itself with differentiators. Differentiators are the opposite of integrators. Differentiators also have a square wave input but produce spiked or peaked waveform outputs.



RC DIFFERENTIATOR

The output is taken across the resistor. The time constant is short with respect to the input pulse width. The time constant will usually be 10 times or more less than the input pulse width.



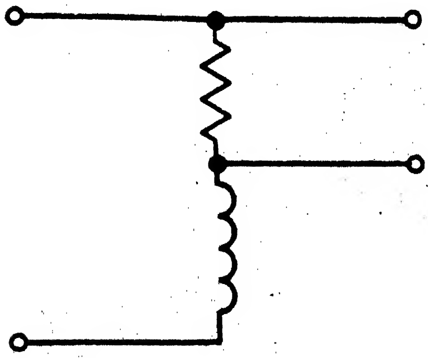
$$TC = RC$$
$$= 10 \times .01 \times 10^{-6}$$
$$= .1 \ \mu sec$$

RC DIFFERENTIATOR

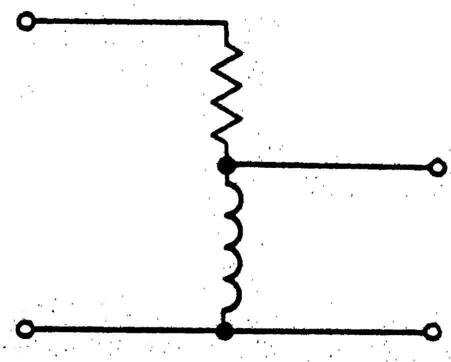
The characteristics of an RC differentiators are:

1. Square wave input; spiked or peaked waveform out.
2. The output is taken across the resistor.
3. The RC time constant is short (usually $\frac{1}{10}$ or less) with respect to the input pulse width.

There are also L/R differentiators and integrators, because at low frequencies capacitors must be very large and this is not practical.



L/R INTEGRATOR



L/R DIFFERENTIATOR

The characteristics of the L/R integrator and differentiator are the same as the RC circuits, except inductors are used instead of capacitors and the outputs are taken from different points. The L/R integrator's output is taken across the resistor and the differentiator's output is taken across the coil.

Another difference is the method in which time constant is figured.

The inductance is divided by the resistance, $T_c = \frac{L}{R}$, instead of multiplied like the RC.

The following jingle may help you remember the type of outputs integrators and differentiators produce.

<u>I</u> saw <u>D</u> spikes.

I = integrator = sawtooth waveform

D = differentiator = spikes (peaked waveform)

AT THIS POINT YOU SHOULD PROCEED TO THE JOB PROGRAM.

JOB PROGRAM
FOR
LESSON III

Integrators

EQUIPMENT AND MATERIALS

1. Device 6F16 and TEMPLATE #1
2. Oscilloscope
3. 1X Test Probe (3)

PROCEDURES

1. Energize the oscilloscope, and set it up for operation on Channel 1. Set Channel 1 controls and switches as follows:

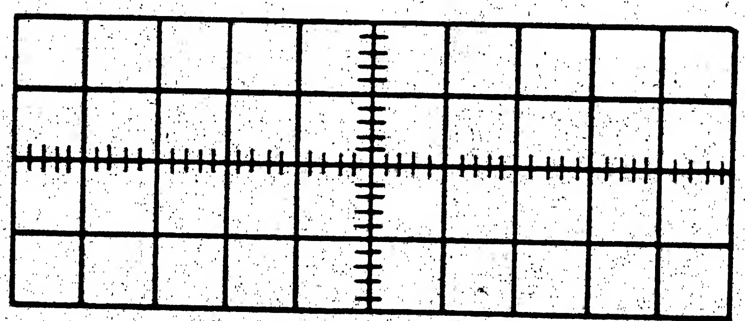
   a. TIME/DIV - 2 MILLISECS/DIV
   b. VOLTS/DIV - 10 VOLTS/DIV
   c. Obtain a line trace and center it exactly on the horizontal axis.

2. a. Place Template #1 on the 6F16, and plug in the indicated components.

   b. Attach a 1X probe to the oscilloscope calibrator output jack, and set calibrator output switch to 20 volts. This will be your input to the integrator. Attach the other end of the test probe to the input of your circuit. Attach the probe ground lead to circuit ground.

   c. Another way of obtaining the required input is to use a square wave generator set at 20 volts at 1 KHz.

3. Connect another 1X probe to Channel 1 of the oscilloscope. Connect the test probe to the input of the circuit. Observe and draw the input waveform.



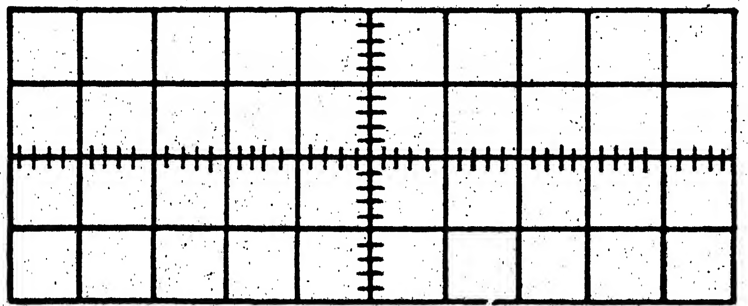
What is the peak-to-peak voltage? ______________________

4. a. Place the oscilloscope DISPLAY MODE switch in the Channel 2 position, and obtain a line trace. Set channel 2 switches and controls as follows:

   1. VOLTS/DIV - 5 VOLTS/DIV
   2. TIME/DIV - 2 MILLISECS/DIV

   b. Center the line trace exactly on the horizontal axis.

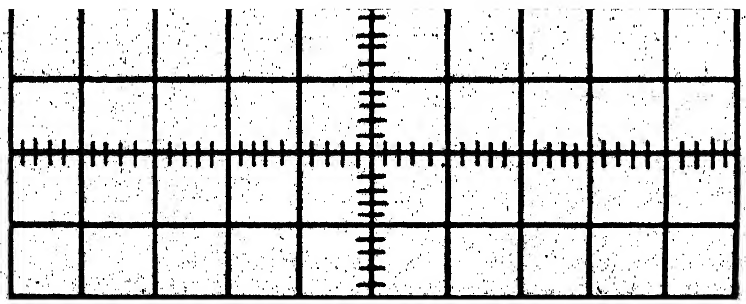
   c. Connect a 1X test probe to Channel 2. Now, observe and draw the output waveform.



What is the peak-to-peak voltage? ______________________

5. Is this an integrator or a differentiator? ______________________

6. Place the DISPLAY MODE switch in the chop position. Observe and draw the waveforms as displayed on the oscilloscope. (You are observing the input waveform on Channel 1, and the output waveform on Channel 2).



Notice how much the output is attenuated? This is because the capacitor is not being allowed to charge fully during each half cycle.

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JOB PROGRAM FOR LESSON III PART 2

DIFFERENTIATORS

EQUIPMENT AND MATERIALS

1. Training Device 6F16 and TEMPLATE #2
2. Oscilloscope
3. 1X test probe (3)

PROCEDURES

1. Energize the oscilloscope, and obtain a line trace on Channel 1. Set Channel 1 switches and controls as follows:

   a. TIME/DIV - 2 MILLISEC/DIV
   b. VOLTS/DIV - 10 VOLTS/DIV
   c. Center the line trace on the horizontal axis.

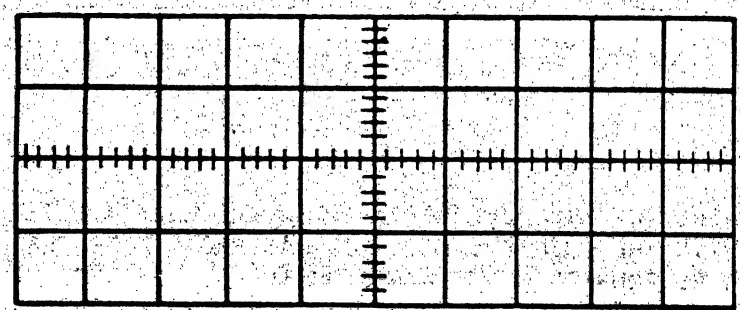
2. Now, you are going to assemble the opposite of an integrator - a differentiator. If an integrator has a long time constant, then a differentiator must have a ______________________________. That's right, a short time constant.

3. Place Template #2 on the 6F16, and add the required components.

4. Connect a 1X Probe to the oscilloscope calibrator output jack, and set calibrator output to 20 VOLTS. As in part one of this job program, an alternate method of obtaining the required input waveform would be to use a square wave generator set at 20 volts peak-to-peak at 1 KHz.

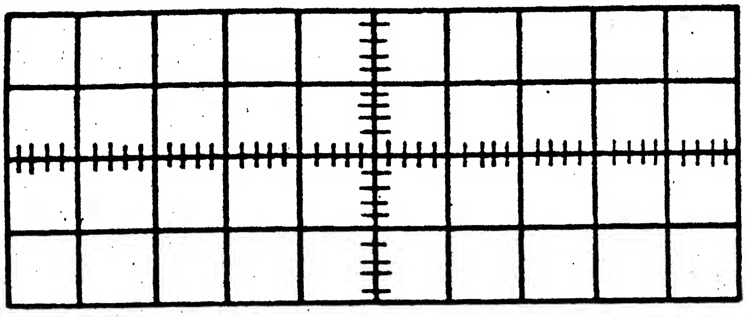
5. Connect the other end of the probe to the input of the circuit as you did in part one of this job program.

6. Connect another 1X test probe to Channel 1 of the oscilloscope. Connect the other end of the test probe to the input of the circuit. Now, observe and draw the input waveform.



What is the peak-to-peak voltage?

2. Connect the channel "2" IX test probe to the output of the differentiator. Observe and draw the output waveform. (You didn't forget to turn the display mode switch to channel "2", did you?)



NOTE: Don't be alarmed if you can't see the entire waveform. When the signal first starts to go positive or negative (leading edge), it happens so quickly (almost instantaneously) that the oscilloscope can't follow it.

3. What is the output peak-to-peak voltage?____________________

4. Now, locate a 33 k Ω resistor and put in place of the 4.7 K Ω resistor. What will happen to the output? It is now (more/less) differentiated? Did the output amplitude increase or decrease sharply? By how much? ________________________

5. Now replace the 33 K Ω resistor with a 10 K Ω resistor. Which resistor (33 K Ω, 10 K Ω, or 4.7 K Ω) produced the "best" differention?

6. You have now built RC integrators and differentiators and looked at the inputs and outputs of each. This leaves only the LR type circuits (integrators and differentiators.) You will not be able to construct these as the 6F16 doesn't have these capabilities. Remember how they were covered in the written media? LR circuits produce the same outputs as RC circuits. The only difference is where you take the outputs.

This concludes the Job Program on Integrators and Differentiators. Secure the test equipment and put all the components back in their proper places.

CHECK YOUR RESPONSES TO THIS JOB PROGRAM WITH THE ANSWER SHEET. IF YOUR RESPONSES AGREE WITH THE ANSWER SHEET, YOU MAY TAKE THE LESSON PROGRESS CHECK. IF YOUR RESPONSES DO NOT AGREE OR IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST OF THIS JOB PROGRAM, REVIEW THE PROCEDURES OF THIS JOB PROGRAM, ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS OR CONSULTATION WITH LEARNING CENTER INSTRUCTOR, UNTIL YOUR RESPONSES DO AGREE.

PROGRESS CHECK
LESSON III

Integrators and Differentiators

1. An RC integrator's output is taken across the ________________.

2. An L/R integrator's output is taken across the ________________.

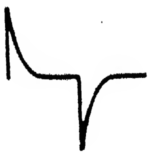
3. An RC differentiator's output is taken across the ______________.

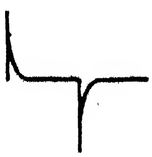
4. An L/R differentiator's output is taken across the ______________.

5. An integrator has a (long/short) time constant with respect to the input pulse.

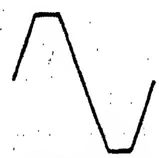
6. A differentiator has a (long/short) time constant with respect to the input pulse.

7. Which of the illustrated output waveforms indicates the shortest time constant?

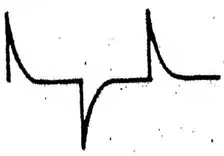
a. 

b. 

c. 

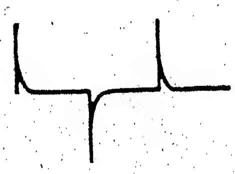
d. 

8. Which of the illustrated output waveforms indicates the longest time constant?

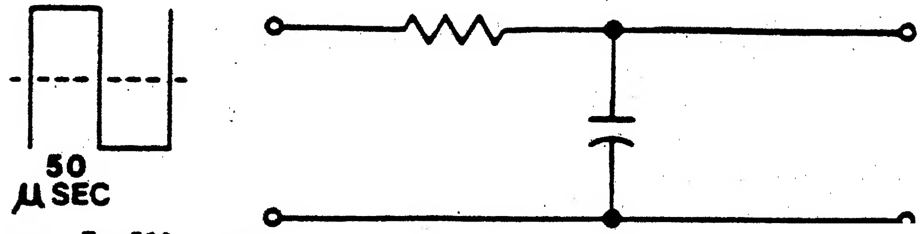
a. 

b. 

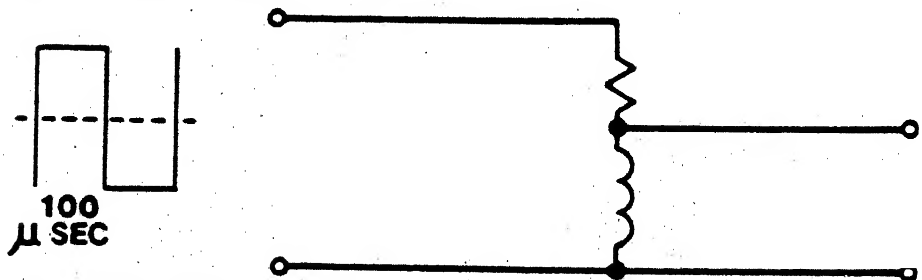
c. 

d. 

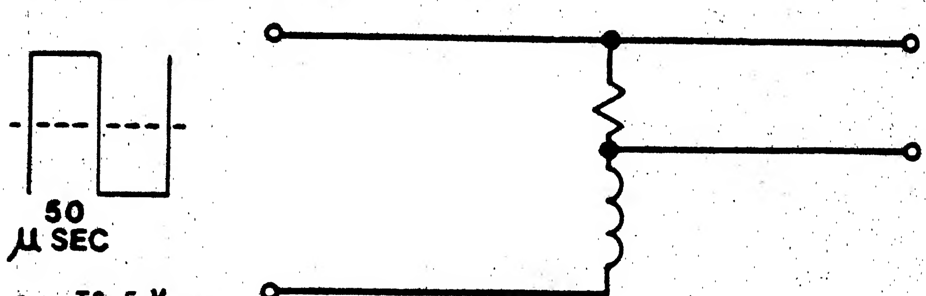
9. Match the illustrated circuits with their most correct names.



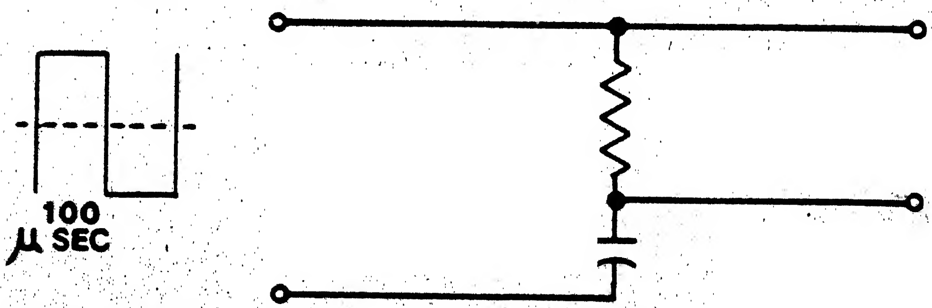
a. Tc=500 µ sec



b. TC=5 µsec



c. TC=5 Msec



d. TC=10 µsec

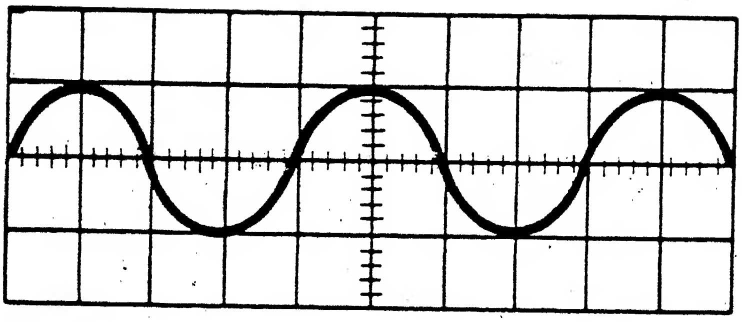
1. L/R differentiator
2. RC differentiator
3. L/R integrator
4. RC integrator

CHECK YOUR ANSWERS TO THIS PROGRESS CHECK WITH THE ANSWERS IN THE BACK OF YOUR STUDENT GUIDE. IF YOU FEEL THAT YOU HAVE FAILED TO UNDERSTAND ANY PART OF THIS LESSON YOU SHOULD CONSULT YOUR LEARNING CENTER INSTRUCTOR FOR ASSISTANCE AND REMEDIATION. IF YOU ANSWERED ALL QUESTIONS IN THE PROGRESS CHECK CORRECTLY, CONSULT YOUR LCI FOR ASSIGNMENT TO THE MODULE TEST.

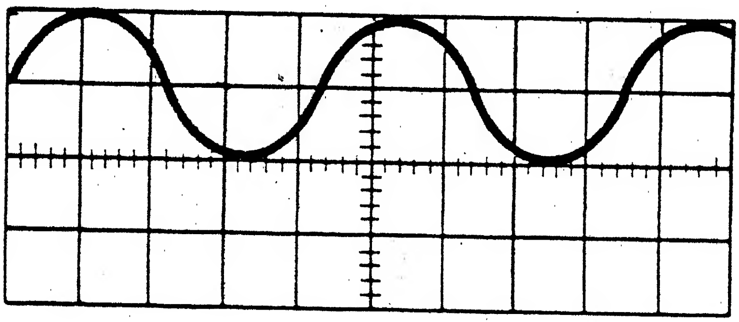
ANSWER SHEET
FOR
JOB PROGRAM
LESSON 11

Clampers

3.

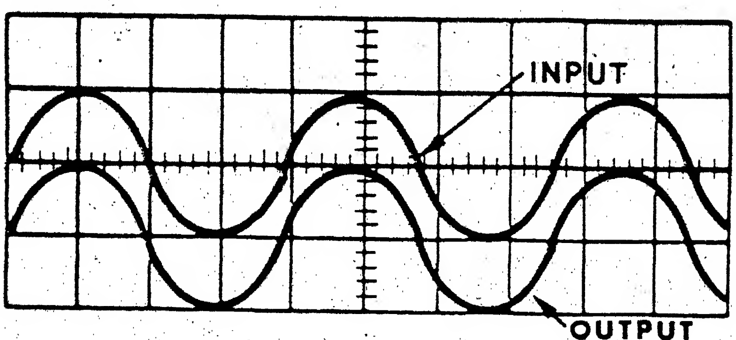


4.



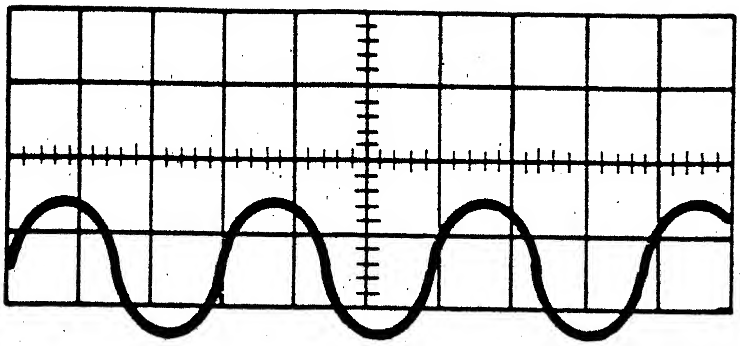
POSITIVE clamper
0 volts

5.



NEGATIVE clamper

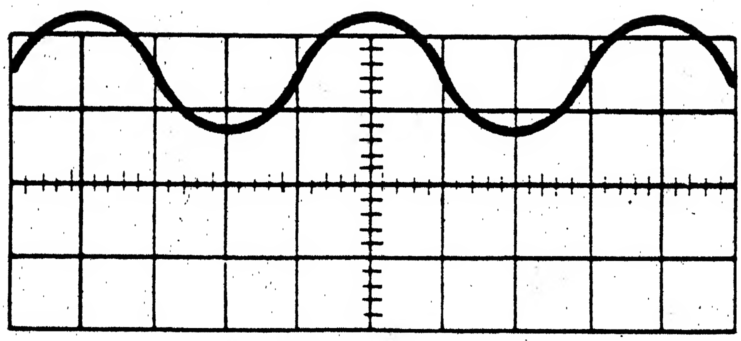
6.

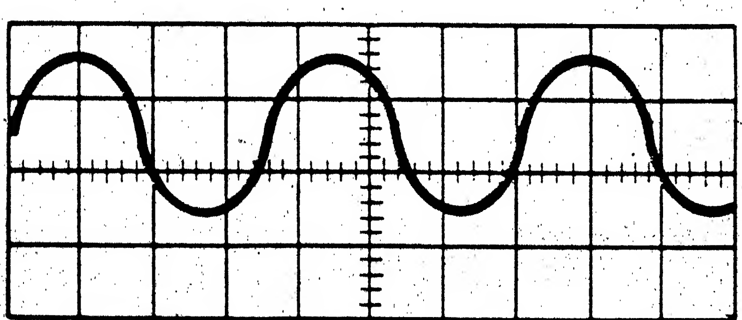


-5 volts

7. YES

8.



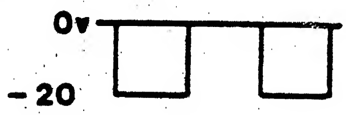


ANSWER SHEET
FOR
PROGRESS CHECK
LESSON II

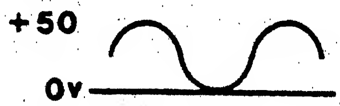
Clampers

QUESTION NO.	CORRECT ANSWER
1.	c.
2.	DC restorer
3.	above
4.	e.
5.	c.
6.	time constant
7.	a.
8.	long
9.	b.

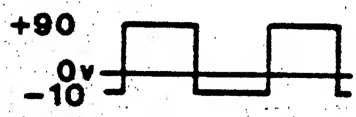
10. a.



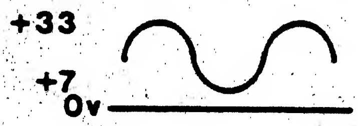
b.



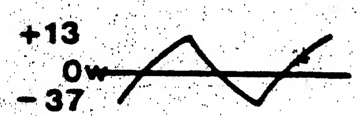
c.



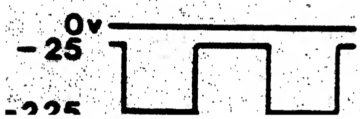
d.



e.



f.



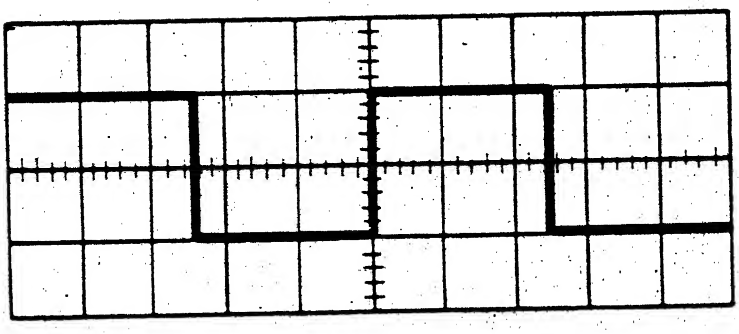
ANSWER SHEET
FOR
PROGRESS CHECK
LESSON II (Cont'd)

QUESTION NO.	CORRECT ANSWER
11. a.	negative clamper
b.	positive clamper
c.	positive clamper with negative bias
d.	positive clamper with positive bias
e.	negative clamper with positive bias
f.	negative clamper with negative bias

ANSWER SHEET
FOR
JOB PROGRAM
LESSON III
PART 1

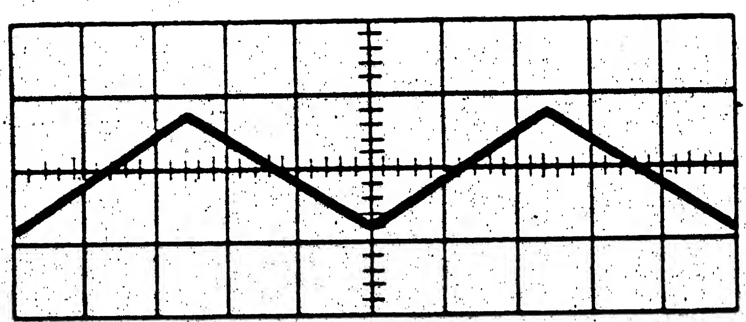
Introduction to Integrators

3.



20 volts p-p

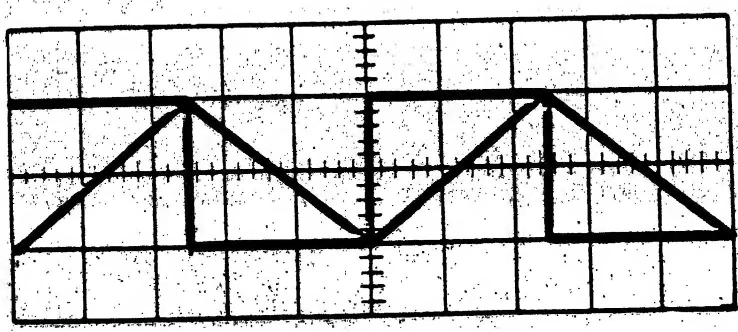
4.



.7 volt p-p

5. integrator

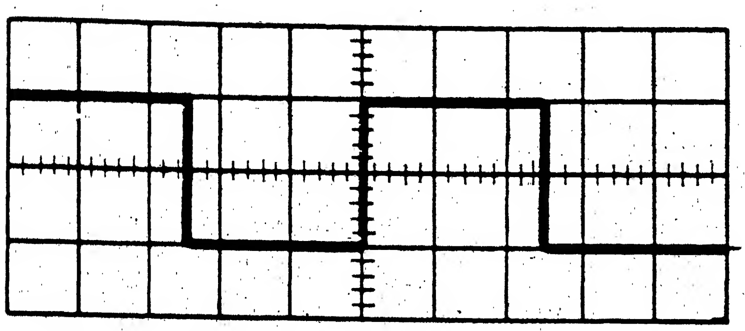
6.



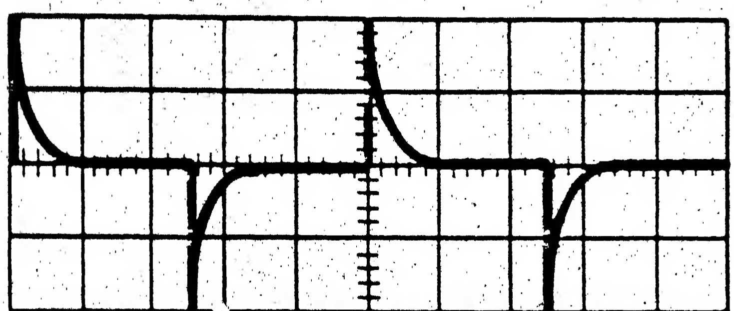
ANSWER SHEET
FOR
JOB PROGRAM
LESSON III
PART 2

Introduction to Differentiators

6.



8.



9. 40 volts p-p

10. less; decrease; 6 volts

11. 4.7 K ohm

ANSWER SHEET
FOR
PROGRESS CHECK
LESSON III

Integrators/Differentiators

QUESTIONS NO.	CORRECT ANSWER
1.	Capacitor
2.	resistor
3.	resistor
4.	coil
5.	long
6.	short
7.	b.
8.	c.
9. a.	(4) RC integrator
b.	(1) L/R differentiator
c.	(3) L/R integrator
d.	(2) RC differentiator